Recovery of Fingerprints from Fire Scenes and Associated Evidence

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A lack of information concerning the potential recovery of fingerprints from fire scenes and related evidence prompted several research projects. Latent prints from good secretors and visible prints (in blood) were placed on a variety of different surfaces and subsequently subjected to "real life" fires in fully furnished compartments used for fire investigation training purposes. The items were placed in various locations and at different heights within the compartments. After some initial success, further tests were undertaken using both latent and dirt/grease marks on different objects within the same types of fire compartments. Subsequent sets of tests involved the recovery of latent and visual fingerprints (in blood, dirt and grease) from different types of weapons, lighters, plastic bags, match boxes, tapers, plastic bottles and petrol bombs that had been subjected to the same fire conditions as previously. Throughout the entire series of projects one of the prime considerations was how the resultant findings could be put into practice by fire scene examiners in an attempt to assist the police in their investigations. This research demonstrates that almost one in five items recovered from fire scenes yielded fingerprint ridge detail following normal development treatments.

La falta de información en relación con la posible recuperación de huellas dactilares en escenas de incendios y evidencias relacionadas, ha promovido varios proyectos de investigación. Se colocaron en una variedad de superficies, huellas latentes de buenos secretores y huellas visibles (sangre) y se sometieron a fuegos "reales" en apartamentos totalmente amueblados utilizados para el entrenamiento de la investigación por fuegos. Las huellas fueron colocadas en diversos sitios y a diversas alturas dentro de los apartamentos. Después de un cierto éxito inicial, se realizaron nuevas pruebas usando huellas latentes y huellas de grasa/suciedad en diferentes objetos dentro del mismo tipo de apartamentos de fuego. Subsiguientes conjuntos de pruebas incluyeron la recuperación de huellas dactilares latentes y visibles (en sangre, suciedad y grasa) de diferentes tipos de armas, encendedores, bolsas de plástico, cajas de cerillas, velas, botellas de plástico y bombonas de gasolina que habían sido sometidas a las mismas condiciones de fuego anteriores.
A través de toda la serie de proyectos, una de las principales consideraciones fue como los investigadores podían poner en práctica los hallazgos resultantes con el objetivo de ayudar a la policía en sus investigaciones. Este trabajo demuestra que casi una de cada cinco huellas recuperadas de la escena del fuego produce detalle del surco de la huella dactilar de acuerdo con tratamientos de desarrollo normal.

Ein Mangel an Information die mögliche Sicherung von Fingerabdruckspuren an Brandorten und zugehörigen Beweismitteln betreffend war Anlass für mehrere Forschungsprojekte. Latente Fingerabdrücke von guten Spurengebern und sichtbare Abdrücke (in Blut) wurden auf einer Auswahl verschiedener Oberflächen gesetzt und anschließend „authentischen" Feuern in voll möblierten, abgeteilten Räumen ausgesetzt, die für das Training von Brandermittlern benutzt werden. Die Gegenstände wurden an unterschiedlichen Stellen in unterschiedlicher Höhe in diesen Räumen platziert. Nach den ersten Erfolgen wurden weitere Versuche mit latenten Abdrücken und solchen in Schmutz und Fett auf verschiedenen Objekten in gleichartigen Räumen unternommen. Weitere Tests beinhalteten die Sicherung von latenten und sichtbaren Fingerabdruckspuren (in Blut, Schmutz und Fett) von verschiedenen Waffen, Feuerzeugen, Plastikbeuteln, Streichholzschachteln, Papierlunten, Plastikflaschen und Benzinbomben, die unter den gleichen Bedingungen wie zuvor dem Feuer ausgesetzt wurden. Während der ganzen Serie von Projekten war eine der wichtigsten Überlegungen, wie die resultierenden Befunde von den Brandermittlern in die Praxis umgesetzt werden könnten, um die Polizei bei deren Ermittlungen zu unterstützen. Diese Untersuchungen zeigen dass an nahezu einem Fünftel der an Brandorten gesicherten Gegenständen detaillierte Papillarleistenabdrücke mit üblichen Methoden zur Sichtbarmachung erhalten wurden.

Un manque d'information concernant le potentiel de recouvrement de traces digitales à partir de scènes de feu et d'autres types d'indices ont conduit à développer plusieurs projets de recherche. Les traces latentes de bons sécréteurs et des traces visibles (dans le sang) ont été placées sur une variété de surfaces différentes et ont été ensuite soumises à des feux de « taille réelle » dans des compartiments complètement meublés utilisés à des fins d'entraînement pour l'investigation des feux. Les items ont été placés à divers endroits à différentes hauteurs au sein des compartiments. Après quelques succès initiaux, d'autres tests ont été entrepris en utilisant aussi bien des traces latentes et sales / graisseuses sur différents objets dans le même type de compartiments de feu. Les séries de tests subséquentes comprenaient la récolte des traces latentes et visuelles (dans le

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sang, la saleté et la graisse) de différents types d'armes, de briquets, de sacs en plastique, de boîtes d'allumettes, d'adhésifs, de bouteilles en plastique et de bombes incendiaires qui avaient été assujettis aux mêmes conditions de feu qu'auparavant. Dans l'ensemble des séries de projets, l'une des considérations primaires était de savoir comment les résultats trouvés pouvaient être mis en pratique par les investigateurs de scènes de feu afin d'assister la police dans ses investigations. Cette recherche démontre qu'à peu près un sur cinq objets récolté des scènes de feu présente des détails de crête papillaire à la suite de traitements et développements normaux.

Introduction

From the author's experience the vast majority of crime scene examiners and forensic scientists have been under a misconception that fingerprints are unlikely to be recovered from fire scenes and associated fire damaged evidence. Indeed there appears on some occasions to be a reluctance to investigate fire scenes as thoroughly as some other scenes, e.g. (non - arson) murder scenes, due to the mistaken belief that any evidence therein has been destroyed during the fire. Consequently, it is the author's opinion that a substantial quantity of evidence that could have been used for potential identification purposes has been overlooked at the hundreds of fires that occur every day [1].

Fingerprints are a means of definitively identifying an individual hence their evidential value is immense. There are currently in excess of five million sets of fingerprints on the national automated fingerprint identification system (NAFIS), compared to just over two million on the national DNA database (NDNAD). Therefore, when comparing the likelihood of obtaining a "match" on a fingerprint recovered from a crime scene compared to that of recovered DNA, the fingerprint has currently the greater searchable database [2, 3]. In the context of fire investigation, it can sometimes be relatively easy to prove that a fire was deliberately set [4], yet one of the most challenging facets of an investigation is proving that an individual was responsible for causing that fire. This is probably why the detection rates for the crime of arson (and related charges) are particularly low [5]. Obviously the mere presence of an individual's fingerprint at a fire scene is not sufficient evidence to prove that they committed arson, however it invites a justification of how and why that fingerprint came to be at the scene and it certainly opens up lines of enquiry that might not otherwise have been apparent had such a fingerprint identification not occurred. Consequently, the importance of determining whether or not fingerprints can be recovered from such scenes and the circumstances in which they can be recovered (and surfaces/types of items from which this is possible) is readily evident.

The chemical composition of latent fingerprints has never been completely determined [6] and the composition can change significantly from one person to the next and indeed from one day to another for the same individual [7]. In general, latent fingerprints consist of a variety of inorganic and organic substances, mainly secreted by the eccrine and sebaceous sweat gland of the body. In addition, they can often contain varying degrees of contamination from the person's environment [6]. The physical and chemical properties of a fingerprint will be affected by exposure to a number of phenomena that occur in every flaming fire, such as light (electro-magnetic radiation), water and elevated temperatures, and consequently it might be suspected that the composition of a fingerprint (latent or visible) will vary throughout the duration of a fire. However, the purpose of this paper was not to explore the resultant change in composition of fingerprints pre- and post-fire, but to demonstrate that fingerprints **can** be recovered from fire damaged scenes, to investigate the types of surfaces from which visualisation and/or recovery is possible and to assist scene examiners to optimise their examinations and evidence recovery.

Methods

Full scale fire scenes were furnished according to six different scenarios, encompassing social, domestic and commercial environments. Each scene comprised a single compartment static mobile home constructed of aluminium outer shells with timber flooring. The internal walls comprised a sandwich of timber and plasterboard enclosing thermal insulation; the internal walls were skimmed with plaster and painted with emulsion[1]. All windows were glazed with a single pane of glass and there were venting panels built into some compartment walls. The furniture, fittings and floor coverings were all sourced from second-hand shops and were of modern and traditional design and construction. Each compartment was supplied with single phase alternating current (AC) electricity and there were numerous electrical outlets within each compartment.

Fingerprints were deposited on a large variety of items and surface types ranging from smooth glass, plastic and wood to paper, metal and fabrics, as described in the experimental section. A range of fingerprint donors was used, and different types of prints were deposited, e.g. latent (sweat), grease/dirt and blood. The items were placed in various locations throughout the compartments, some in close proximity to the fire seat(s), some in more protected environments, and at varying heights throughout the scenes.

All scenes were recorded photographically prior to ignition, and the burns were recorded by colour video camera up to the point of extinguishing. The compartments were equipped with three high temperature thermocouples, located at floor, ceiling and

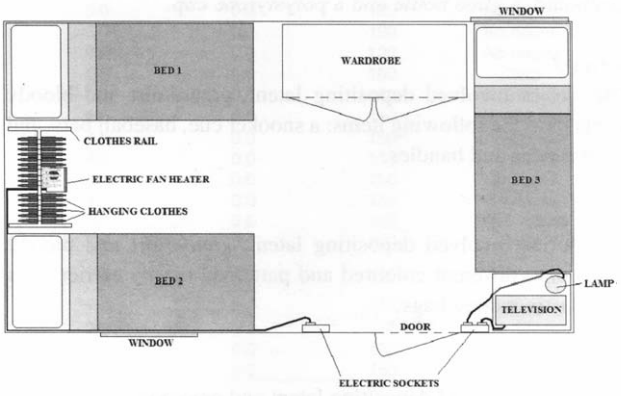


Figure 1 Example plan of a typical fire compartment layout.

1 Some compartment walls were lined with woodchip wallpaper prior to being painted over with emulsion.

mid-height positions, and data was captured on a laptop computer via a TC-08 multi-channel thermal data logger.

The fires were set using a variety of different methods encompassing both accidental and deliberate ignition. Fire suppression involved a two-person BA crew[2] equipped with two hose reel jets; each fire was knocked down by "pulse spray" fire fighting and post-fire disturbance during damping down was kept to a necessary minimum.

Prior to recovery of the different samples for fingerprint treatment and examination, all items were photographed *in situ*. Appropriate packaging materials were used to ensure the preservation of any fingerprints.

Experimental

In total, eight different series of experiments were undertaken. Seven series involved the furnished compartments as described above; however one series (series 5) was unrelated to the fire scenes in that it involved the preparation and throwing of seventeen petrol bombs (some with paper wicks and some with fabric wicks). The various fingerprint and substrate types for each series of experiments are described below. Items were placed at different locations and heights within the compartments (the detail relating to this information can be found in the tables of results), and at varying distances from the origin(s) of the respective fires.

Series 1
This series involved depositing latent and bloody prints onto the following items: plastic bottles, a plastic-cased heater, a multi-way electric plug adaptor, newspapers, glass bottles and glasses, a metal drinks can, a disposable cigarette lighter and wood-chip wallpaper.

Series 2
This series involved depositing latent and grease/dirt prints onto the following items: a cigarette packet, a metal drinks can, plastic bottles/containers, newspaper, boxes of matches, cardboard, a glass bottle and a polystyrene cup.

Series 3
This series involved depositing latent, grease/dirt and bloody prints onto the following items: a snooker cue, baseball bats, and knife blades and handles.

Series 4
This series involved depositing latent, grease/dirt and bloody prints onto different coloured and patterned plastic carrier bags and plastic money bags.

Series 5
This series involved depositing latent and grease/dirt prints onto petrol bombs comprising glass beer bottles with fabric, paper or cardboard wicks.

Series 6
This series involved depositing latent prints onto the plastic and metal components of numerous disposable cigarette lighters.

Series 7
This series involved depositing latent prints onto newspaper tapers (tightly rolled) that were subsequently dipped into various ignitable liquids (turpentine substitute, white spirit and petrol).

Series 8
This series involved depositing latent prints onto matchboxes/books of matches.

The development of fingerprints was undertaken by Thames Valley Police Fingerprint Development Laboratory (TVPFDL) and the Home Office Scientific Development Branch (HOSDB) in accordance with the relevant procedures for retrieval of prints from such surfaces as detailed in the Fingerprint Development Handbook [6]. Following the treatment of each item, all of the developed marks were photographed. Subsequently, each mark was examined by the author and the quality of visible ridge detail was assessed.

Results

Hundreds of latent and visible fingerprints were deposited on 177 separate items, comprising different surface types, in various fire scene scenarios. Due to the destructive nature of fire it was not possible to recover all of the items; some were destroyed or irreversibly damaged during the fire, whilst others were simply not found within the compartments following the fire fighting operation.

The results of each experimental series are summarised in tables 1–8 following.

Each developed mark was recorded photographically. Photographs 'A' to 'P' show examples of fingerprints on a range of items and different surfaces. Ridge detail was visible post-fire on 18% of the total items used in this study. However, of the 25 different types of items that were placed in the fire scenes, visible fingerprint ridges were developed on 50% of those item types. Examples of objects within those item types are plastic bags and bottles, matchboxes, metal drinks cans, knife blades and handles, wooden baseball bats and various types of paper.

Although the temperatures attained in the individual compartments (at three levels of height) were recorded for each fire, it is not necessary, nor practical, to present the temperature profile graph for every compartment. To illustrate the range of conditions to which the items would have been subjected, three time-temperature graphs have been selected: those for the compartments that attained the overall maximum and minimum temperature ranges, and one that attained typically mid-range temperatures.

2 Breathing Apparatus Crew.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail	Corresponding Photograph
S1/JJD/1	Washing-up liquid bottle	Smooth plastic	Latent	1.8	0.6	600	No ridges	-
S1/JJD/2A	Pepsi bottle	Smooth plastic	Latent	3.0	0.0	150	No ridges	-
S1/JJD/2B	Coca-Cola bottle	Smooth plastic	Latent	3.0	0.0	150	No ridges	-
S1/JJD/3	Newspaper	Paper	Latent	6.6	0.4	600	No ridges	-
S1/JJD/4	Rolled newspaper	Paper	Latent	6.6	0.0	200	Good	A
S1/JJD/5	Plastic bottle	Smooth plastic	Latent	2.5	0.5	625	No ridges	-
S1/JJD/6	Fan heater	Smooth plastic	Latent	0.0	0.0	800	No ridges	-
S1/JJD/7	Multi-way socket adaptor	Smooth plastic	Blood	0.6	0.0	800	Very clear	B, C, D, E, F
S1/JJD/8	Evian bottle	Smooth plastic	Latent	6.0	0.0	800	Good	G, H
S1/JJD/8	Evian bottle (label)	Paper	Blood	6.0	0.0	800	Very good	I
S1/JJD/9	Stella Artois bottle	Smooth glass	Latent	1.5	0.6	750	No ridges	-
S1/JJD/10A	Beer can (empty)	Smooth metal	Latent	2.1	0.6	750	No ridges	-
S1/JJD/10B	Beer can (empty)	Smooth metal	Latent	2.1	0.6	750	No ridges	-
S1/JJD/10C	Beer can (empty)	Smooth metal	Latent	2.1	0.6	750	No ridges	-
S1/JJD/11	CD case	Smooth plastic	Latent	6.6	0.6	750	No ridges	-
S1/JJD/12	Matchbox	Smooth card	Latent	1.5	0.3	250	No ridges	-
S1/JJD/13	Light switch	Smooth plastic	Blood	1.8	1.4	400	No ridges	-
S1/JJD/14	Glass bottle (part full)	Smooth glass	Latent	0.0	0.7	650	Not recovered	-
S1/JJD/15	Drinking glass	Smooth glass	Latent	0.3	0.7	650	Not recovered	-
S1/JJD/16	Drinking glass	Smooth glass	Latent	0.3	0.7	650	Not recovered	-
S1/JJD/17	Beer can (part full)	Smooth metal	Latent	0.9	0.7	650	Not recovered	-
S1/JJD/18	Cigarette lighter	Smooth plastic	Latent	2.5	0.5	650	Not recovered	-
S1/JJD/19	Wall	Woodchip Wallpaper	Blood	1.8	1.4	400	Faint ridges	-
S1/JJD/20	Cupboard door	Melamine	Blood	5.7	0.6	400	No ridges	-

Table 1 Summary of the results obtained for series 1.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail
S2/JJD/1	Cigarette packet	Paper	Latent	3.0	0.7	625	No ridges
S2/JJD/2	Beer can (empty)	Smooth metal	Dirt	3.6	0.7	635	Fragments visible
S2/JJD/3	Plastic bottle	Smooth plastic	Latent	1.5	0.8	625	No ridges
S2/JJD/4	Plastic container	Smooth plastic	Latent	3.0	0.0	100	Clear
S2/JJD/5	Newspaper 'torch'	Paper	Latent	3.0	0.0	300	No ridges
S2/JJD/6	Beer Can (empty)	Smooth metal	Latent	1.0	0.7	650	No ridges
S2/JJD/7	Beer Can (empty)	Smooth metal	Latent	1.5	0.7	650	No ridges
S2/JJD/8	Matchbox	Smooth card	Latent	3.0	0.0	300	No ridges
S2/JJD/9	Plastic Bottle (empty)	Smooth plastic	Latent	3.0	0.0	120	No ridges
S2/JJD/10	Beer Can (empty)	Smooth metal	Latent	5.0	0.0	120	No ridges
S2/JJD/11	Beer Can (empty)	Smooth metal	Latent	6.0	0.0	120	No ridges
S2/JJD/12	Newspaper	Paper	Latent	6.0	0.0	120	No ridges
S2/JJD/13	Newspaper	Paper	Latent	6.0	0.0	150	Clear
S2/JJD/14	Matchbox	Smooth card	Latent	6.0	0.0	150	No ridges
S2/JJD/15	Plastic container	Smooth plastic	Latent	3.0	0.0	150	No ridges
S2/JJD/16A	Glass bottle	Smooth glass	Latent	4.5	0.0	150	No ridges
S2/JJD/16B	Cardboard wick	Smooth cardboard	Latent	4.5	0.0	150	No ridges
S2/JJD/17	Beer can (empty)	Smooth metal	Latent	5.1	0.0	150	No ridges
S2/JJD/18	Beer can (empty)	Smooth metal	Latent	4.5	0.0	150	No ridges
S2/JJD/19	Matchbox	Smooth card	Grease/dirt	3.0	0.0	150	Faint ridges
S2/JJD/20	Disposable cup	Polystyrene	Grease/dirt	2.4	0.0	150	Clear
S2/JJD/21	Plastic bottle (part full)	Smooth plastic	Latent	5.4	0.0	150	No ridges
S2/JJD/22	Plastic bottle (empty)	Smooth plastic	Latent	5.4	0.0	150	No ridges
S2/JJD/23	Plastic bottle (empty)	Smooth plastic	Latent	3.0	0.0	150	No ridges
S2/JJD/24	Plastic bottle (empty)	Smooth plastic	Latent	3.0	0.0	150	No ridges
S2/JJD/25	Plastic container	Smooth plastic	Latent	6.0	0.0	150	No ridges

Table 2 Summary of the results obtained for series 2.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail	Corresponding Photograph
S3/JJD/1	Baseball bat (A)	Varnished wood	Latent	3.04	0.15	500	No ridges	-
S3/JJD/2	Part Snooker cue	Varnished wood	Latent	3.04	0.38	950	No ridges	-
S3/JJD/3	Baseball bat (B)	Varnished wood	Latent/blood/ grease	3.04	0.0	500	No ridges	-
S3/JJD/4	Snooker cue	Varnished wood	Latent	3.04	0.9	225	Item destroyed	-
S3/JJD/5	Baseball bat (C)	Varnished wood	Latent	2.43	0.0	475	Item destroyed	-
S3/JJD/6	Baseball bat (D)	Varnished wood	Dirt/blood	6.09	0.0	225	Clear-fragmented	-
S3/JJD/7	Baseball bat (E)	Varnished wood	Latent	0.0	0.0	225	Item not found	-
S3/JJD/8	Baseball bat (F)	Varnished wood	Latent	1.82	0.0	250	No ridges	-
S3/JJD/9	Baseball bat (G) black lacquer painted handle	Varnished wood	Dirt/Latent/ Blood/Grease	6.09	0.0	500	Clear detail	J
S3/JJD/10	Knife (A) wood handle	Polished metal	Latent	6.09	0.0	500	No ridges	-
S3/JJD/11	Knife (B) wood handle	Polished metal	Latent	6.09	0.0	475	No ridges	-
S3/JJD/12	Knife (C) wood handle	Polished metal	Latent	3.04	0.15	500	No ridges	-
S3/JJD/13	Knife (D) wood handle	Polished metal	Latent	0.6	0.0	225	No ridges	-
S3/JJD/14	Knife (E) wood handle	Polished metal	Latent	3.04	0.38	950	No ridges	-
S3/JJD/15	Knife (F) wood handle	Polished metal	Latent	5.48	2.45	800	No ridges	-
S3/JJD/16	Knife (G) wood handle	Polished metal	Latent	6.09	0.0	225	Blood ridges fragmented	-
S3/JJD/17	Knife (H) wood handle	Polished metal	Latent	3.04	0.38	775	No ridges	-
S3/JJD/18	Knife (I) plastic handle	Polished metal	Latent	2.43	0.6	250	Clear-Fragmented	-
S3/JJD/19	Knife (J) plastic handle	Polished metal	Latent	0.6	0.9	950	No ridges	-
S3/JJD/20	Knife (K) wood handle	Polished metal	Latent/blood/ grease	0.9	0.9	950	Item not found	-
S3/JJD/21	Knife (L) wood handle	Polished metal	Latent	3.04	0.0	500	No ridges	-
S3/JJD/22	Baseball bat (H)	Wood handle/ synthetic tape	Latent	5.48	0.0	475	No ridges	-

Table 3 Summary of the results obtained for series 3.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail	Corresponding Photograph
S4/JJD/1	Nat. West Cash bag (A)	Plastic	Latent	3.04	0.7	1050	Item destroyed	-
S4/JJD/2	Nat. West Cash bag (B)	Plastic	Latent	3.35	0.4	1050	Item destroyed	-
S4/JJD/3	Nat. West Cash bag (C)	Plastic	Latent	3.35	0.4	1050	Item destroyed	-
S4/JJD/4	Nat. West Cash bag (D)	Plastic	Latent	2.43	0.7	275	No ridges	-
S4/JJD/5	Nat. West Cash bag (E)	Plastic	Latent	2.43	0.7	275	Item destroyed	-
S4/JJD/6	Nat. West Cash bag (F)	Plastic	Latent	2.43	0.7	275	No ridges	-
S4/JJD/7	Nat. West Cash bag (G)	Plastic	Latent	3.04	0.6	700	Item destroyed	-
S4/JJD/8	Nat. West Cash bag (H)	Plastic	Latent	3.04	0.2	300	No ridges	-
S4/JJD/9	Nat. West Cash bag (I)	Plastic	Latent	3.04	0.2	300	Item destroyed	-
S4/JJD/10	White Laundry Carrier Bag (A)	Plastic	Latent/Dirt/Blood	6.70	0.0	875	Item destroyed	-
S4/JJD/11	White Laundry Carrier Bag (B)	Plastic	Latent/engine oil	3.35	0.0	875	Item destroyed	-
S4/JJD/12	White Laundry Carrier Bag (C)	Plastic	Latent/engine oil	6.4	0.0	90	Clear ridges/tip of finger	-
S4/JJD/13	White Laundry Carrier Bag (D)	Plastic	Latent/Blood	2.43	0.0	875	Item not found	-
S4/JJD/14	Green Carrier Bag	Plastic	Latent/Blood	0.9	0.7	275	No ridges	-
S4/JJD/15	"Fila" Carrier Bag	Plastic	Latent/Blood	3.04	1.3	800	Item destroyed	-
S4/JJD/16	"Pen Shop" Carrier Bag	Plastic	Latent/engine oil	1.21	0.0	300	No ridges	-
S4/JJD/17	Perfume Carrier Bag	Plastic	Latent/Dirt/engine oil	3.35	0.7	1050	Item not found	-
S4/JJD/18	"Fraser Hart" Carrier Bag	Plastic	Latent/engine oil	2.43	0.0	90	Clear, some fragmented	-
S4/JJD/19	Piece black bin liner (A)	Plastic	Latent	3.35	0.0	875	Item not found	-
S4/JJD/20	Piece black bin liner (B)	Plastic	Latent	3.04	0.7	275	Very clear ridges	K, L
S4/JJD/21	Piece black bin liner (C)	Plastic	Latent	3.65	0.0	300	Very clear ridges	-

Table 4 Summary of the results obtained for series 4.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Quality of Ridge Detail	Corresponding Photograph
	Petrol Bombs						-
S5/JJD/1	Beer bottle-cloth wick (A)	Glass/paper/cloth	Latent/dirt	0.0	1.8	No ridges	-
S5/JJD/2	Beer bottle-cloth wick (B)	Glass/paper/cloth	Latent/dirt	0.0	1.8	No ridges	-
S5/JJD/3	Beer bottle-cloth wick (C)	Glass/paper/cloth	Latent/dirt	0.0	1.8	No ridges	-
S5/JJD/4	Beer bottle-cloth wick (D)	Glass/paper/cloth	Latent/dirt	0.0	1.8	No ridges	-
S5/JJD/5	Beer bottle-cloth wick (E)	Glass/paper/cloth	Latent/dirt	0.0	1.8	No ridges	-
S5/JJD/6	Beer bottle-paper wick (A)	Glass/paper	Latent	0.0	1.8	Clear/fragmented	M
S5/JJD/7	Beer bottle-paper wick (B)	Glass/paper	Latent	0.0	1.8	No ridges	-
S5/JJD/8	Beer bottle-paper wick (C)	Glass/paper	Latent	0.0	1.8	No ridges	-
S5/JJD/9	Beer bottle-paper wick (D)	Glass/paper	Latent	0.0	1.8	No ridges	-
S5/JJD/10	Beer bottle-paper wick (E)	Glass/paper	Latent	0.0	1.8	No ridges	-
S5/JJD/11	Beer bottle-paper wick (F)	Glass/paper	Latent	0.0	1.8	No ridges	-
S5/JJD/12	Beer bottle-cardboard wick (A)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	No ridges	-
S5/JJD/13	Beer bottle-cardboard wick (B)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	No ridges	-
5/JJD/14	Beer bottle-cardboard wick (C)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	*Bottles not thrown Safety factor	-
S5/JJD/15	Beer bottle-cardboard wick (D)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	Bottles not thrown Safety factor	-
S5/JJD16	Beer bottle-cardboard wick (E)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	Bottles not thrown Safety factor	-
S5/JJD/17	Beer bottle-cardboard wick (F)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	Bottles not thrown Safety factor	-
S5/JJD/18	Beer bottle-cardboard wick (G)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	Bottles not thrown Safety factor	-
S5/JJD/19	Beer bottle-cardboard wick (H)	Glass/paper/cardboard	Latent/dirt	0.0	1.8	Bottles not thrown Safety factor	-

*Structure of wick led to liquid flowing out of bottle rendering the device hazardous to throw

Table 5 Summary of the results obtained for series 5.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail
S6/JJD 1/1	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.4	0.0	850	Item destroyed
S6/JJD 1/2	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.3	0.0	750	No ridges
S6/JJD 1/3	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.6	0.0	450	No ridges
S6/JJD 1/4	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.2	0.0	100	No ridges
S6/JJD 1/5	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.3	0.0	100	No ridges
S6/JJD 1/6	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.3	0.4	975	Item destroyed
S6/JJD 1/7	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.6	0.6	975	Item not found
S6/JJD 1/8	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.5	0.6	975	No ridges
S6/JJD 1/9	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.8	0.9	375	No ridges
S6/JJD 1/10	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.8	0.8	975	Item not found
S6/JJD 2/1	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.5	0.0	425	No ridges
S6/JJD 2/2	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.5	0.0	425	No ridges
S6/JJD 2/3	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.9	0.0	425	No ridges
S6/JJD 2/4	Disposable Cigarette Lighter	Plastic/Metal	Latent	0.1	0.0	425	No ridges
S6/JJD 2/5	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.3	0.0	425	Item destroyed
S6/JJD 2/6	Disposable Cigarette Lighter	Plastic/Metal	Latent	2.4	0.5	700	No ridges
S6/JJD 2/7	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.5	0.6	700	No ridges
S6/JJD 2/8	Disposable Cigarette Lighter	Plastic/Metal	Latent	3.0	0.0	425	Faint ridges
S6/JJD 2/9	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.2	0.4	700	No ridges
S6/JJD 2/10	Disposable Cigarette Lighter	Plastic/Metal	Latent	1.2	0.2	700	No ridges
S6/JJD 3/1	Disposable Cigarette Lighter	Plastic/Metal	Latent	2.4	0.0	75	Item destroyed
S6/JJD 3/2	Disposable Cigarette Lighter	Plastic/Metal	Latent	2.7	0.0	75	Item destroyed
S6/JJD 3/3	Disposable Cigarette Lighter	Plastic/Metal	Latent	3.6	0.0	75	No ridges
S6/JJD 3/4	Disposable Cigarette Lighter	Plastic/Metal	Latent	3.3	0.0	75	No ridges
S6/JJD 3/5	Disposable Cigarette Lighter	Plastic/Metal	Latent	3.0	0.0	75	No ridges
S6/JJD 3/6	Disposable Cigarette Lighter	Plastic/Metal	Latent	6.09	0.0	75	No ridges
S6/JJD 3/7	Disposable Cigarette Lighter	Plastic/Metal	Latent	6.09	0.0	75	No ridges
S6/JJD 3/8	Disposable Cigarette Lighter	Plastic/Metal	Latent	5.18	0.15	75	No ridges
S6/JJD 3/9	Disposable Cigarette Lighter	Plastic/Metal	Latent	4.87	0.0	75	No ridges
S6/JJD 3/10	Disposable Cigarette Lighter	Plastic/Metal	Latent	3.0	0.0	75	No ridges

Table 6 Summary of the results obtained for series 6.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (cm)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail
S7/JJD/1	Taper-white spirit/petrol	Newspaper	Latent	0.0	0.0	125	No ridges
S7/JJD/2	Taper-turp.substitute	Newspaper	Latent	0.0	0.0	200	No ridges
S7/JJD/3	Taper-turp.substitute	Newspaper	Latent	0.0	0.4	200	Clear ridges
S7/JJD/4	Taper-turp.substitute	Newspaper	Latent	0.0	0.0	700	No ridges
S7/JJD/5	Taper-turp. substitute	Newspaper	Latent	0.0	0.0	700	No ridges
S7/JJD/6	Taper - white spirit	Newspaper	Latent	0.0	0.0	425	No ridges

Table 7 Summary of the results obtained for series 7.

Item Reference	Item	Surface	Type of Prints Deposited	Approximate Distance of Item from the Origin of the Fire (m)	Approximate Height of Item Above Floor (m)	Maximum Temperature Attained at that Height (approx°C)	Quality of Ridge Detail	Corresponding Photograph
S8/JJD/1	Matchbox	Smooth card	Latent	1.0	0.0	750	Clear ridges	-
S8/JJD/2	Book of matches	Smooth card	Latent	1.5	0.0	750	Not retrieved	-
S8/JJD/3	Matchbox	Smooth card	Latent	1.5	0.7	850	No ridges	-
S8/JJD/4	Matchbox	Smooth card	Latent	3.0	0.0	750	Not retrieved	-
S8/JJD/5	Matchbox	Smooth card	Latent	3.0	0.2	750	Not retrieved	-
S8/JJD/6	Matchbox	Smooth card	Latent	0.5	0.6	850	No ridges	-
S8/JJD/7	Matchbox	Smooth card	Latent	1.5	0.7	850	No ridges	-
S8/JJD/8	Matchbox	Smooth card	Latent	1.5	0.0	750	Clear ridges	-
S8/JJD/9	Matchbox	Smooth card	Latent	1.5	0.0	750	Clear ridges	-
S8/JJD10	Book of matches	Smooth card	Latent	4.0	0.0	550	Not retrieved	-
S8/JJD/11	Book of matches	Smooth card	Latent	4.0	0.4	550	No ridges	-
S8/JJD/12	Matchbox	Smooth card	Latent	4.0	0.0	550	No ridges	-
S8/JJD/13	Matchbox	Smooth card	Latent	4.5	0.0	550	Destroyed	-
S8/JJD/14	Matchbox	Smooth card	Latent	3.0	0.7	1150	No ridges	-
S8/JJD/15	Matchbox	Smooth card	Latent	3.0	0.0	550	Clear ridges	-
S8/JJD/16	Matchbox	Smooth card	Latent	2.5	0.0	550	Destroyed	-
S8/JJD/17	Matchbox	Smooth card	Latent	2.0	0.5	1150	Destroyed	-
S8/JJD/18	Matchbox	Smooth card	Latent	4.0	0.0	550	No ridges	-
S8/JJD/19	Book of matches	Smooth card	Latent	5.0	0.0	725	No ridges	-
S8/JJD/20	Matchbox	Smooth card	Latent	6.0	0.0	725	No ridges	-
S8/JJD/21	Matchbox	Smooth card	Latent	5.0	0.0	725	No ridges	-
S8/JJD/22	Matchbox	Smooth card	Latent	2.5	0.0	725	No ridges	-
S8/JJD/23	Matchbox	Smooth card	Latent	4.0	0.0	725	No ridges	-
S8/JJD/24	Matchbox	Smooth card	Latent	3.0	1.9	925	No ridges	-
S8/JJD/25	Matchbox	Smooth card	Latent	3.0	0.0	725	Very clear ridges	N, O, P
S8/JJD/26	Matchbox	Smooth card	Latent	5.0	0.7	900	Clear ridges	-
S8/JJD/27	Matchbox	Smooth card	Latent	6.0	0.0	725	Clear ridges	-
S8/JJD/28	Matchbox	Smooth card	Latent	3.0	0.0	725	No ridges	-

Table 8 Summary of the results obtained for series 8.

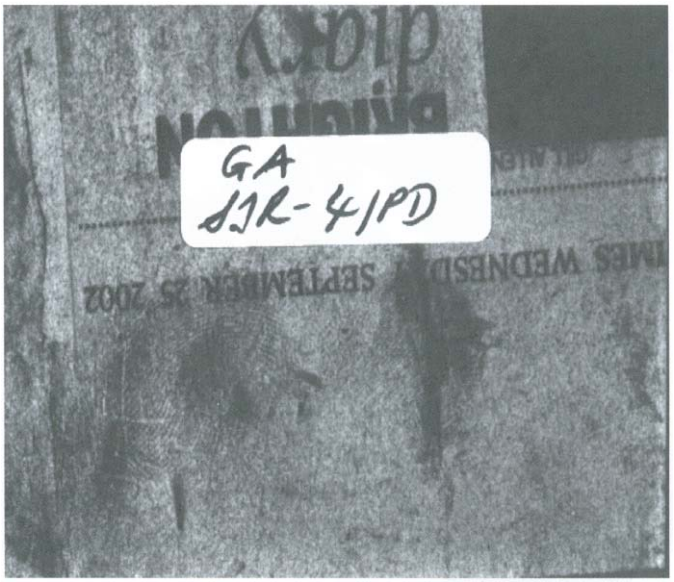


PHOTO 'A' – ITEM S1/JJD/ 4
Fingerprint developed, post-fire, by Physical Developer on wet newspaper used as a 'torch'.

PHOTO 'B' – ITEM S1/JJD/ 7
Top surface, post-fire, of multi-way socket adaptor bearing blood fingerprint on base.

PHOTO 'C' – ITEM S1/JJD/ 7
Carpet adhering to base of multi-way socket adaptor, post-fire.

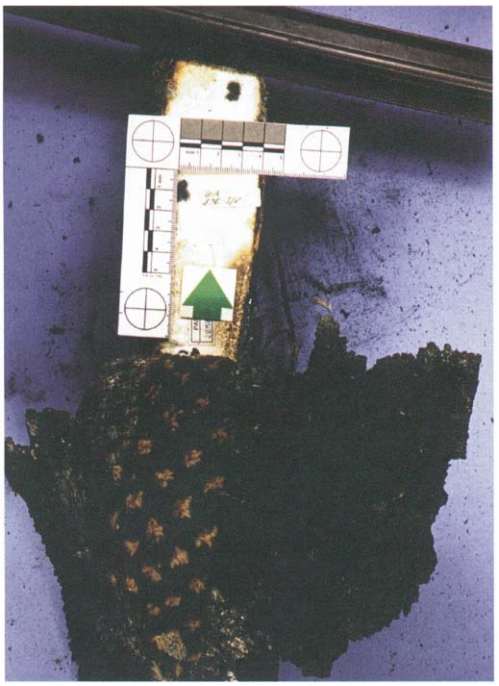


PHOTO 'D' – ITEM S1/JJD/ 7
Carpet peeled back, post-fire, revealing blood fingerprint indicated by green arrow on base of multi-way socket adaptor.

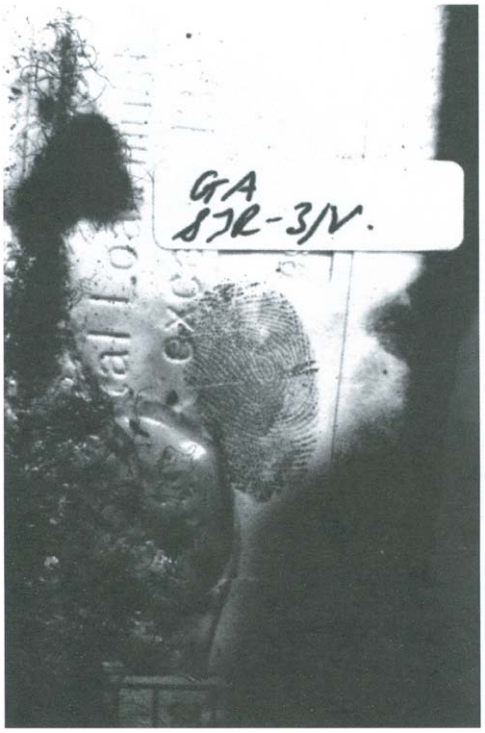


PHOTO 'E' – ITEM S1/JJD/ 7
Blood fingerprint on base of multi-way socket adaptor, post-fire.

PHOTO 'F' – ITEM S1/JJD/ 7
Enlargement of blood fingerprint on base of multi-way socket adaptor, post-fire.

PHOTO 'G' – ITEM S1/JJD/ 8
Aluminium powder fingerprint on side of Evian water bottle, post fire.

PHOTO 'H' – ITEM S1/JJD/ 8
Aluminium powder fingerprint on side of Evian water bottle, post-fire.

PHOTO 'I' – ITEM S1/JJD/ 8
Blood fingerprint, developed by Amido Black treatment, post-fire on label of Evian water bottle.

PHOTO 'J' – ITEM S3/JJD/ 9
Enlargement of fingerprint developed by Cyanoacrylate (super glue) and Quaser light, post fire, on charred handle of baseball bat.

PHOTO 'K' – ITEM S4/JJD/ 20
Bin liner, post-fire, showing surface which was facing downwards on to top of desk. Cyanoacrylate (super-glue) palm mark developed on this surface.

PHOTO 'L' – ITEM S4/JJD/ 20
Enlargement of palm mark developed, post fire, by Cyanoacrylate (super glue) and Quaser light, on plastic bin liner.

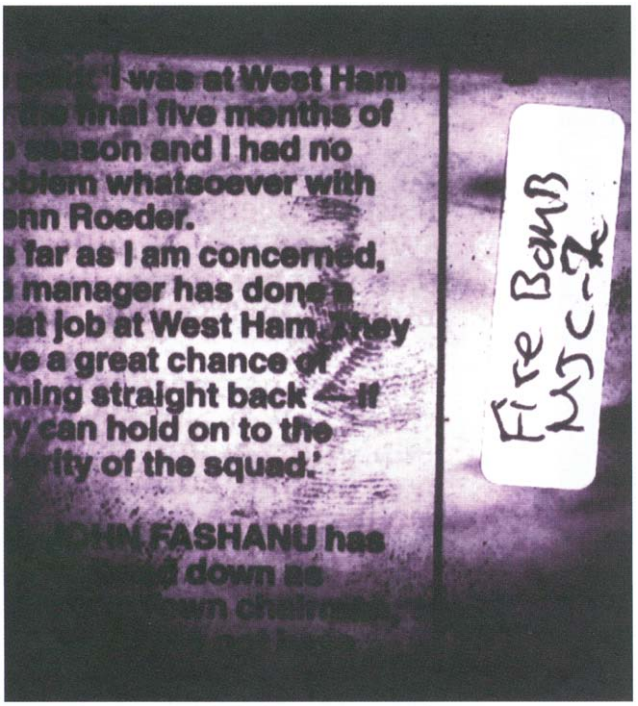
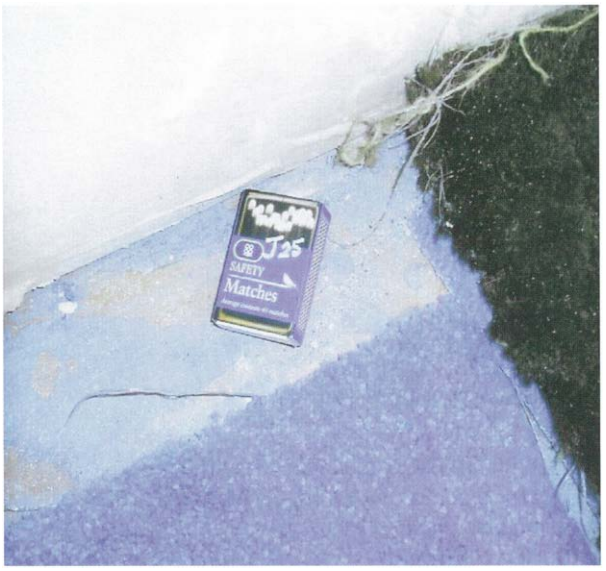


PHOTO 'M' – ITEM S5/JJD/ 6
Enlargement of fingermark developed, post fire, by Ninhydrin, on piece of newspaper used as a wick in a petrol bomb.



PHOT0 'N' – ITEM S8/JJD/ 25
Match box bearing latent fingerprints, on floor, pre-fire.

PHOTO 'O' – ITEM S8/JJD/ 25
Match box, post-fire

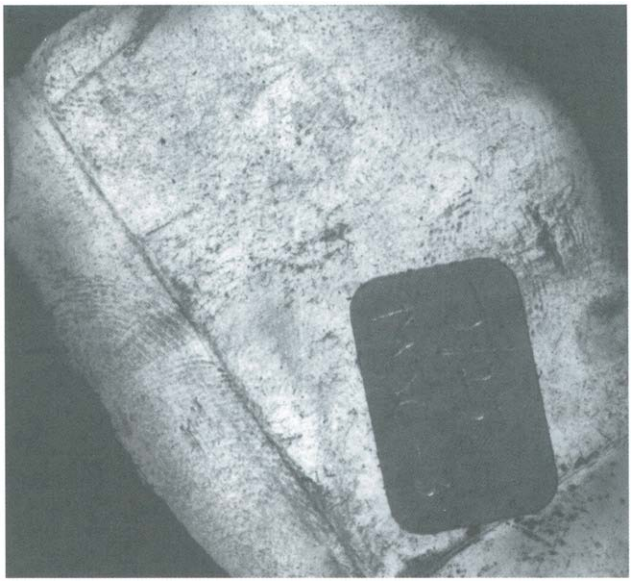


PHOTO 'P' – ITEM S8/JJD/ 25
Match box, showing fingerprints developed by Physical Developer, on inner tray, post-fire.

Discussion

The range and extents of temperatures recorded in the various compartments are typical of those reached in typical domestic and commercial premise fires [4]. Furthermore, all items were exposed to normal fire fighting procedures such as being covered in water and possibly moved and/or handled during damping down. Consequently, it can be concluded that all items have been subject to conditions that are truly representative of the fire scenes encountered in the real world.

A wide range of substrate types and different items were placed in the various scenes; these items were chosen to represent items typically encountered at crime scenes, including ones where a weapon may have been used by a perpetrator prior to the fire. Deposited latent, blood and grease/dirt marks survived on objects that were located in close proximity to the seat of the fire as well as those placed in remote or protected areas. In addition, marks survived on items located at heights considerably above floor level within the compartments where they were subjected to temperatures significantly above ambient. Despite these conditions, it was possible to develop clear ridge detail that could be used for identification purposes. Scene examiners should therefore be open minded to the potential to recover useable marks from fire scenes.

The range of substrates on which ridge detail was successfully developed is vast, from plastic and glass, to wood, cardboard and paper. In some instances marks that had been deposited as latent sweat marks pre-fire were visible post-fire and required only direct photography.

Marks tended to survive on surfaces that had some degree of protection, such as those facing downwards or on articles placed below a chair or in waste bins. Therefore, it is objects in these locations or situations that should be obvious targets for recovery from the scene and subsequent fingerprint development processes. However, there are some remarkable exceptions to this generality. Consequently, no items within fire scenes should be overlooked for recovery simply because they appear to have been severely damaged as a result of the fire, be it due to smoke deposition, radiated heat or direct flame impingement. One noteworthy exception is the mark developed on the upward facing side of the baseball bat handle shown in photograph 'J' (exhibit S3/JJD/9). This mark was developed by cyanoacrylate (super glue) fuming and visualised using a Quaser light source. Even though the upward facing surface of the handle had been subjected to significant radiant heat damage during the fire (and temperatures around 500°C), becoming blistered and cracked, the latent (sweat) mark placed thereon prior to the fire was amenable to chemical treatment and ridge detail was clearly visible following visualisation. This mark received no protection at all from the harsh fire conditions in the compartment.

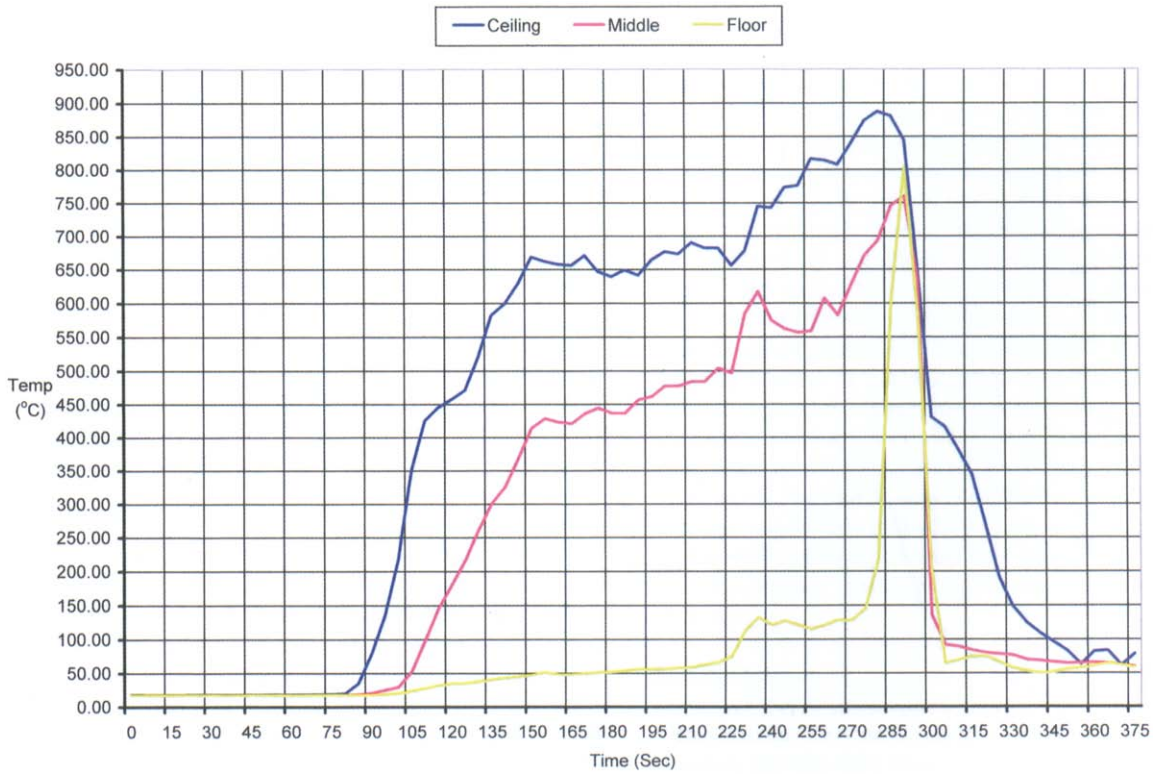


Figure 2 Time temperature graph for the compartment that attained the highest overall temperature. (Series 1)

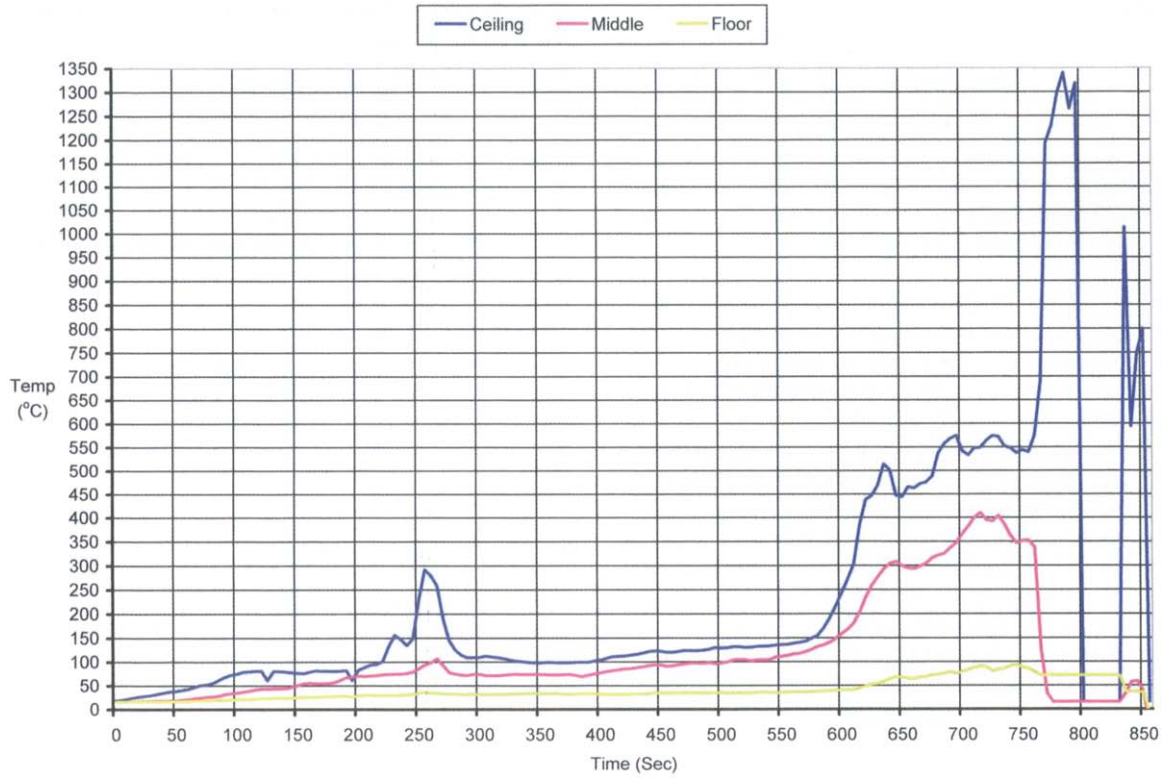


Figure 3 Time temperature graph for the compartment that attained typically mid-range temperatures. (Series 1)

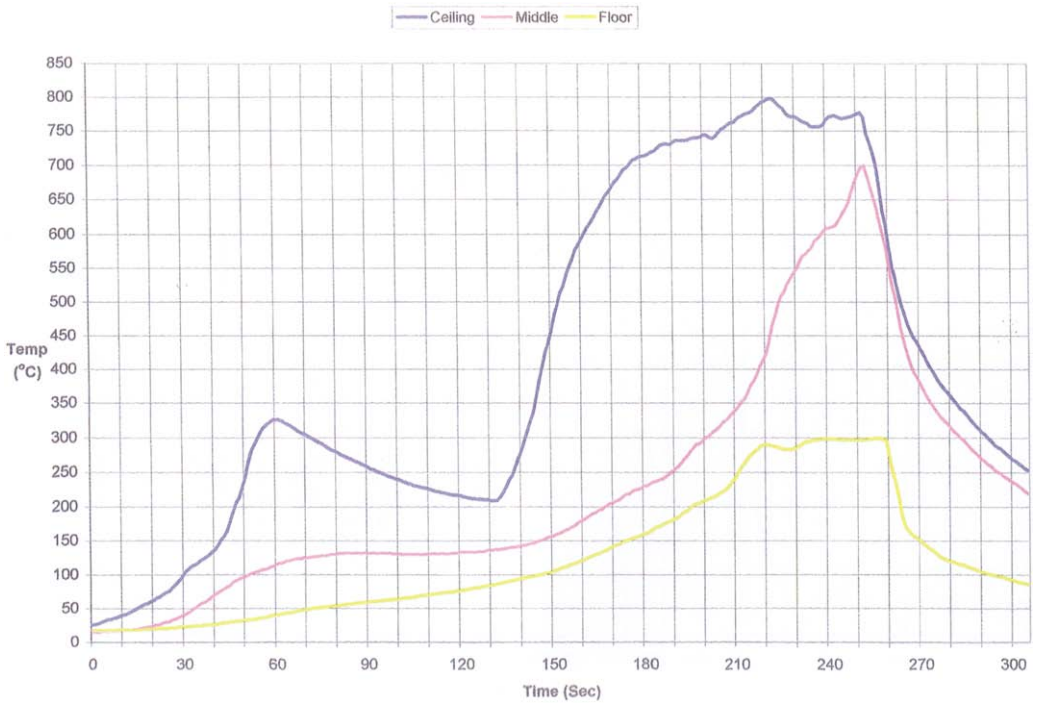


Figure 4 Time temperature graph for the compartment that attained the lowest overall temperature. (Series 4)

Other items worthy of individual mention are as follows. Photograph 'E' shows the blood mark that survived on the base of a plug adaptor (exhibit S1/JJD/7). This mark was protected by being on the base of the adaptor which was facing downwards onto the carpet. The adaptor itself was severely damaged post-fire, with the majority of the upwards part of the object being consumed during the fire and the remainder of the plastic melting onto the carpet. Nonetheless, the base of the adaptor was unaffected by the fire and, after cutting around the item (with the adaptor still *in situ*) and carefully removing the carpet by incision from the underside, the blood mark was clearly visible. The floor level temperature in the vicinity of the adaptor was in the region of 800°C, thus proving that blood marks can survive extreme conditions such as flash-over. It should be emphasised that in this instance the blood fingerprint was placed on an electric plug adaptor; however, in a 'real' crime scene the article on which the mark could have been located may well have been a weapon such as a knife blade or handle, or a metal bar, and the significance of finding such a mark requires no further elaboration.

There were numerous other blood marks that survived, however the mark shown in photograph 'I' is also one that was subjected to a high temperature, namely around 800°C. This Evian bottle, item S1/JJD/8 had been placed in a waste bin where the label had been protected by surrounding papers. Although the fingerprint was visible prior to development, following treatment with Amido Black, the ridge detail was exceptionally clear.

Item S3/JJD/18 was a plastic handled knife, located two feet above the floor in the compartment. Despite the upper surface of the knife being severely burnt during the fire, the latent (sweat) marks on the knife blade, on the surface facing the shelf, survived and were able to be directly photographed without the need for any chemical treatment. Other marks requiring no chemical treatment post-fire were those made in car engine oil onto a plastic carrier bag Item S4/JJD/18. These marks survived on the upward facing surface of the carrier bag. Despite the bag being located on the floor underneath a desk, and as such received a certain amount of protection from direct radiant heat, temperatures in that vicinity were elevated above ambient at around 90°C.

A particularly clear palm impression was chemically developed by cyanoacrylate fuming and Quaser light on a plastic bin liner Item S4/JJD/20 (Photograph 'L') on the surface facing downwards onto a desk top. This area reached temperatures of approx. 275°C.

Also worth mentioning are the marks developed on the paper wick of a petrol bomb Item S5/JJD/6 (Photograph 'M') and tapers contaminated with ignitable liquids (for example Item S7/JJD/ 3. With regard to the former, this latent (sweat) print survived on the wick because it was on the inside surface of the rolled up newspaper, thus being protected from the direct effects of the fire which burnt only the outside surface of the paper. Conventional development using ninhydrin revealed the print. Along the same lines fingerprints were retrievable from the inner surfaces of the rolled up newspaper taper Item S7/JJD/3, despite the item being soaked in white spirit prior to ignition. Development in this instance was by using physical developer.

Thirty disposable lighters were used in Series 6, two of which were treated by HOSBD using a new slant on vacuum, metal, deposition (VMD), namely one using silver as opposed to the conventional zinc and gold. On one of the two lighters an indication of ridge detail was evident. The remaining 28 lighters were treated by TVPFDL where the new VMD treatment was not available. It could be that, had all 30 lighters been treated using the new VMD method, more ridge detail would have been developed. The new VMD process is the subject of a continuing collaborative research project between the author and HOSDB.

The results of the series involving matchboxes/books of matches, were a particularly good example of surfaces protected from the direct effect of the fire, producing good fingermarks. Of the 28 items placed in the fire scenes, eight produced fingermarks of which six were on the bottom of the inner tray of the matchbox. The condition of the boxes post-fire, varied from light soot covering to heavily burnt and disintegrated. The photographs 'N', 'O' and 'P' on Item S8/JJD/25 are a clear example of fingermarks surviving and reacting to chemical development by physical developer despite the matchbox being severely charred, exposed to temperatures around 725°C, wetted and partly disintegrated by the fire.

It is acknowledged that fire/arson scenes pose a challenge to the scene examiner in terms of fingerprint recovery. Nonetheless, 18% of the total items produced marks with visible ridges and the author considers this an encouraging recovery rate. In fact, if the disposable lighters were omitted from the numbers, since it is known that these are notoriously difficult objects for successfully developing marks, the percentage of items that produced marks rises to 20%. This equates to one in every five items recovered on which fingerprints were successfully developed. Although there are numerous factors that influence the likelihood of successful retrieval of fingerprints from articles, such as the training, experience and discretion of the individual working within the fire scene, on the basis of this research scene examiners should be more confident when assessing whether or not to recover items, and indeed which items to recover, for fingerprint examination from fire scenes; this mind-set and approach should also be instilled into Crime Scene Managers (CSMs), Senior Investigating Officers (SIOs) and Scientific Support Managers (SSMs), although it is accepted that time and budget restraints will be a consideration. As a result of these projects, it should now be accepted that there is a distinct possibility that fingermarks can, and will, be found at fire scenes.

Conclusions

The aim of this research was to approach the subject of retrieval of fingermarks from fire scenes from the viewpoint of the scene examiner; this was not a laboratory based project to develop new methods of visualisation, nor was its purpose to investigate the scientific reasons why fingermarks survive conditions of fire. Instead, the experiments were intended to give an indication of

the possibility of marks being recovered on common articles likely to be present when the scene is examined for evidential purposes. Moreover, the intention was to counteract the commonly held view that the likelihood of fingermarks being retrieved from fire scenes is virtually zero, and the expenditure of time, resources and money would be better deployed elsewhere.

These series of experiments quite clearly show some remarkable instances where fingermarks have been recovered from items that had been subjected to extremely harsh conditions such as flash-over. This clearly illustrates that fingermarks can be found at fire scenes on a wide range of substrates, from items both in close proximity to the seat of fire and also elsewhere in the locus. Fingermarks in sweat, blood, dirt, grease and Cuprinol have survived thus providing scene examiners with fresh scope. A major factor in the capacity of a mark to persist on an item is for the surface on which the mark was deposited to be protected in some manner, for example by being face down onto a surface, or under items such as desks or chairs. Notwithstanding this, it has been proved that fingermarks can survive in extreme conditions when on surfaces facing upwards to the radiant heat.

As a result of these projects, it should now be accepted that there is a distinct possibility that fingerprints can and will be found and successfully recovered from fire scenes.

Acknowledgements

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